TG: @Chalnaayaaar

Capacitor

SOLUTIONS

Exercise-I (Conceptual Questions)

1. C → Depends material & dimensions only

2. Q = CV

C → does not depend on Q and V

Q ↑ V ↑

3. Charge on capacitor = Charge of positive plate or negative plate. Net charge on capacitor = 0

4. $C = 4\pi\varepsilon_0 R$ and $V = \frac{4}{3}\pi R^3$

$A = 4\pi R^2$

$R = \left(\frac{3V}{A}\right)$

$\therefore \quad C = 12\pi\varepsilon_0\left(\frac{V}{A}\right)$

5. Current

6. Energy Source → Battery, Capacitor

7. $C = 4\pi\varepsilon_0 R\varepsilon_r \quad \left[\because 2\pi R = 2 \Rightarrow R = \frac{1}{\pi}\right]$

$C = \frac{4\pi\varepsilon_0\varepsilon_r}{\pi}$

$C \approx 2800$ pF

8. Energy supplied by the battery is

$U = CV^2 = Q^2/C = QV$

$= (10^{-6})(300)$

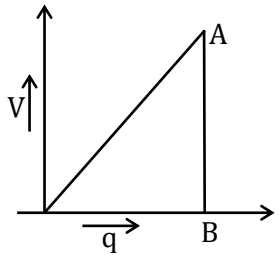
$= 3 \times 10^{-4}$J

9. It does not depend on the resistance

$\frac{1}{2}CV^2 = \frac{1}{2}\times 2\times 10^{-4}\times (200)^2 = 4$J

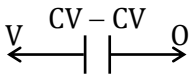
10. $V = \frac{Q}{C}$

11.



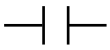
Area $= \frac{1}{2}$ qV = Energy stored in capacitor.

12.



Work = $CV^2 \Rightarrow U = \frac{1}{2}CV^2$

13.



$C = \frac{\in_0 A}{d}$

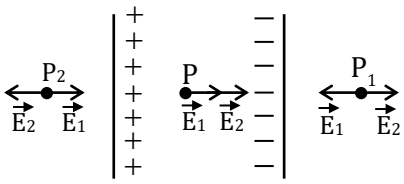
14. $C = \frac{\in_0 A}{d}$

$Q = CV = \frac{\in_0 AV}{d}$

$= \frac{8.85\times 10^{-12}\times 400\times 10^{-4}\times 200}{2\times 10^{-3}}$

$= 3.54 \times 10^{-8}$ C

15.



at P, $E = \frac{q}{2A\varepsilon_0}$

at P_1 & P_2 E = 0

16. r = 20 mm for sphere

$A = \pi r^2$ $C' = 4\pi\in_0 R$

$C = \frac{\in_0 A}{d} \Rightarrow C = C'$

$\frac{\in_0 A}{d} = 4\pi\in_0 R \Rightarrow d = \frac{\in_0 r^2}{4\in_0 R} = 1\times 10^{-4}$ m

$= 0.1$ mm

17. Use $U = \frac{1}{2}\in_0 E^2$

18. Q-same

$U' \propto \frac{1}{C}$ $C' = KC$

$U' = \frac{CU_0}{C'} = \frac{U_0}{K}$

19. Q remains same.

$U = \frac{Q^2}{2C}$

$\therefore \quad C' = KC = 6C$

& $U' = \frac{U}{K} = \frac{U}{6}$

20. $C=\dfrac{\in_0 A}{d-t+\dfrac{t}{K}}$

21. $Q = CV$;
when a slab of dielectric medium is placed capacitance is increased
$Q \propto C$ so charge is also increased

22. Charge does not change. It remains constant.

23. $U=\dfrac{1}{2}CV^2$

$\because$ when a dielectric is inserted then $C\uparrow$ so $U\uparrow$

24. $U=\dfrac{Q^2}{2C}$ $\because$ $C\uparrow$ $\therefore$ $U\downarrow$

25. $U=\dfrac{Q^2}{2C}$

$\because$ $C=\dfrac{\in_0 A}{d}$

If $d\downarrow$ $C\uparrow$ $U\downarrow$

26. $E=\dfrac{V}{d}$

$\because$ $d\uparrow$ $E\downarrow$

$\because$ $Q = CV$ and $C=\dfrac{\in_0 A}{d}$

$\because$ $d\uparrow$ $C\downarrow$ $Q\downarrow$

27. Battery $\rightarrow$ removed
$Q \rightarrow$ constant
$V=\dfrac{Q}{C}$ if $d\uparrow C\downarrow V\uparrow$

28. No

29. $C=\dfrac{\in_0 A}{d}$; $C_1=\dfrac{\in_0 A}{2d}=\dfrac{C}{2}$

$C_2=\dfrac{5\in_0 A}{2d}=\dfrac{5}{2}C$

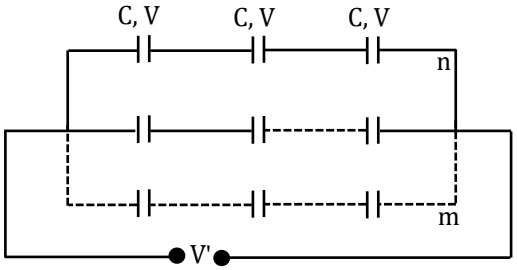
$C_{eq} = C_1 + C_2 = 3C$

$\dfrac{\Delta C}{C}\%=\dfrac{2C}{C}\times 100 = 200\%$

30. $C_{AB}=\dfrac{2}{3}+2=\dfrac{8}{3}\mu F$

31. $V_2 = V_3$
$Q_1 = Q_2 + Q_3$
$V = V_1 + V_2$

32. $C = 1\ \mu F$, $C' = 3\ \mu F$
$V = 500$ V, $V' = 2000$ V



Suppose m rows of given capacitors are connected in parallel and each row now contains n capacitors then potential difference across each capacitor $V=\dfrac{V'}{n}$ and equivalent capacitance of network $C'=\dfrac{mC}{n}$

on putting values,

$\Rightarrow$ $V=\dfrac{V'}{n}$ $\Rightarrow$ $500=\dfrac{2000}{n}$

$n = 4$ $\Rightarrow$ $C'=\dfrac{mC}{n}$

$3=\dfrac{m\times 1}{4}$ $\Rightarrow$ $m = 12$

$\therefore$ total capacitors $= m \times n = 48$

33. Given circuit is balanced wheat stone bridge.
Hence effective capacity is $6\mu F$.

34. $\dfrac{V_1}{V_2}=\dfrac{C_2}{C_1}=\dfrac{10}{1}$

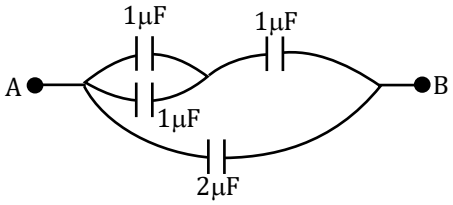
$V_1=\dfrac{500}{11}\times 10=\dfrac{5000}{11}$ volt

35. C and C are in parallel and in series with 2C.
Therefore resultant of these three will be

$$=\frac{(C+C)\times 2C}{C+C+2C}=C$$

This equivalent system is in parallel with C.
It's equivalent capacitance = C + C = 2C
Now, 2C and 2C are in series and in parallel with 2C.
So, C_{net} = C + 2C = 3C

36.



Redraw the circuit $C_{AB}=\dfrac{8}{3}\mu F$

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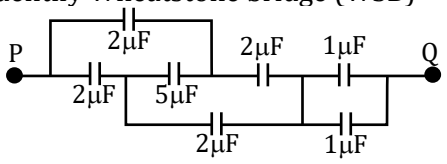
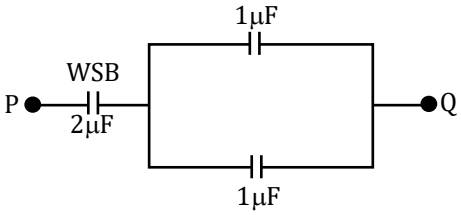
37. Identify Wheatstone bridge (WSB)





$C_{PQ} = 1\mu F$

38. Let Initial charge = q

then from charge conservation

$Q_1 + Q_2 = Q'_1 + Q'_2$

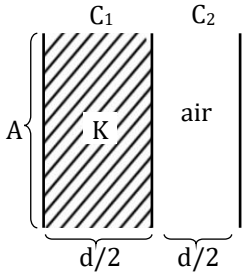
$q + q = C_1V + C_2V = V[C_1+C_2]$

$$V = \frac{2q}{C_1+C_2} = \frac{2q}{4\pi\in_0(R_1+R_2)} = \frac{2kq}{(R_1+R_2)}$$

$$\Rightarrow q = \frac{V(R_1+R_2)}{2k}$$

39. As the potential of two spheres is same hence there will be no flow of charge.

40.



$$C = \frac{\in_0 A}{d} \Rightarrow C_1 = \frac{\in_0 KA}{d/2} = \frac{2\in_0 KA}{d}$$

$$C_2 = \frac{\in_0 A}{d/2} = 2\left(\frac{\in_0 A}{d}\right)$$

C_1 & C_2 are in series combination

$$\text{Hence } \frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{d}{2\in_0 A}\left(\frac{1}{K} + \frac{1}{1}\right)$$

$$\frac{1}{C_s} = \frac{d}{2\in_0 A}\left(\frac{K+1}{K}\right)$$

$$C_s = \frac{2\in_0 A}{d}\left(\frac{K}{K+1}\right) \Rightarrow C_s = \frac{2CK}{K+1}$$

41. Q same $\Rightarrow Q = C_1V_{AD} = C_1(V_1 - V_D)$

and $Q = C_2V_{DB} = C_2(V_D - V_2)$

$C_1(V_1 - V_D) = C_2(V_D - V_2)$

$C_1V_1 + C_2V_2 = (C_1 + C_2)V_D$

$$V_D = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

42. Since both capacitors are in series so charge on each capacitor will be same.

Applying KVL from A to B :-

$$V_A - V_B = \frac{Q}{C_1} - E + \frac{Q}{C_2}$$

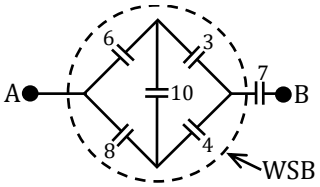
or $$V_A - V_B + E = Q\left[\frac{1}{C_1} + \frac{1}{C_2}\right]$$

$$5 + 10 = Q\left[\frac{3}{2}\times 10^6\right]$$

$$Q = \frac{30}{3} = 10\ \mu C$$

$$V_1 = \frac{Q}{C_1} = \frac{10\times10^{-6}}{1\times10^{-6}} = 10V$$

43. Redraw circuit



C_{net} of W.S.B.

$$= \frac{6\times3}{6+3} + \frac{8\times4}{8+4}$$

$$= 2 + \frac{32}{12} = \frac{14}{3}$$

This is in series with 7

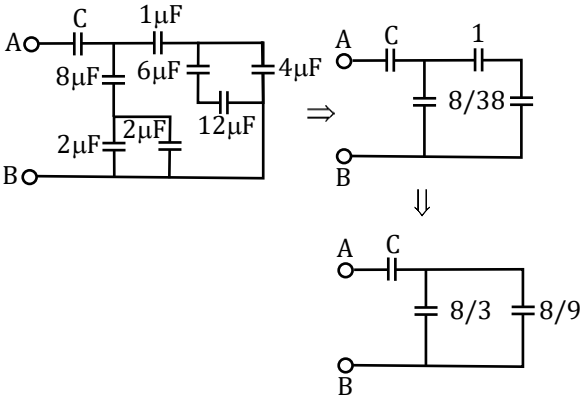
So, $$C_{eq.} = \frac{\frac{14}{3}\times7}{\frac{14}{3}+7} = \frac{14}{5}$$

44. C_{net} of C_1 and C_2, $C_{net} = \frac{C_1C_2}{C_1+C_2}$ $\{C_1 < C_2\}$

So, C_{net} will be smaller than C_1

$C_{net} < C_1 < C_2$ so $\frac{C_1}{2} < C < C_1$

45.



$$C_{AB} = \frac{C\times\frac{32}{9}}{C+\frac{32}{9}} = 1 \Rightarrow C = \frac{32}{23}\mu F$$

46. When capacitor is fully charged. There will be no flow of current through capacitor.

So, $I = \frac{2.5}{2+0.5} = 1\ A$

P.D. across upper branch = $2\Omega \times 1A = 2V$

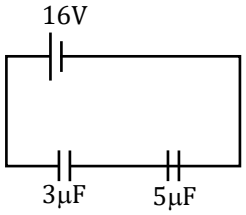
and same voltage on lower branch

$V_C + V_{2\Omega} = 2V$

{but voltage on $2\Omega = 0$ as no current}

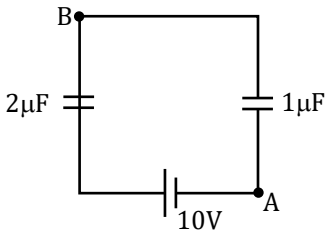
$V_C = 2V$, So $Q = 2V \times 5\mu F = 10\ \mu C$

47.



$V_3 = \frac{5}{3+5} \times 16 = 10V$

48. Given circuit can be reduced as



Charge on capacitors $= \left(\frac{2}{3}\right)(10)\mu C$

Now $V_B - V_A = \left(\frac{20}{3}\right)(1) = \frac{20}{3}$

$\Rightarrow V_B = V_A + \frac{20}{3} = 10 + \frac{20}{3} = \frac{50}{3} V$

49. C_2 & C_3 are in parallel so $V_2 = V_3$

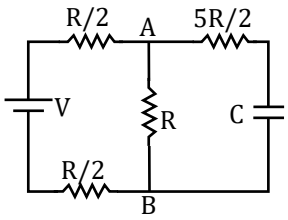
Let $C_1 = C$

$C_2 = C_3 = \frac{C_1}{2} = \frac{C}{2}$

Equivalent of C_2 & $C_3 = \frac{C}{2} + \frac{C}{2} = C$

So $V_1 = V_2 = V_3$

50. In steady state $V_C = V_{AB}$ = capacitor voltage = V/2



51. At $t \to \infty$ $V_{AB} = \frac{V}{2}, i_{AB} = \frac{V}{2R}$

52. Bulb light up during charging

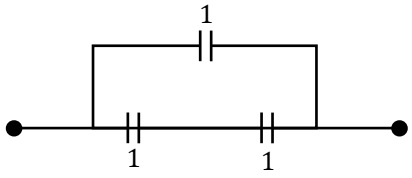
53. $C = \frac{\epsilon_0 A}{d} = 10\ \mu F$

$C_1 = \frac{k_1 \epsilon_0 A}{2d} = 10\ \mu F$

$C_2 = \frac{k_2 \epsilon_0 A}{2d} = 20\ \mu F$

$C_{eq} = C_1 + C_2 = 30\ \mu F$

54.



$C_{net} = 1.5\ \mu F$

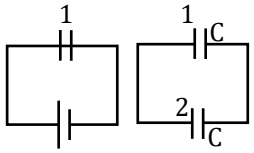
55. Whenever there is transfer of charge some energy dissipates in the form of heat hence potential energy of system decreases.

If $V_1 \neq V_2$ then charge transfer takes place

$\Rightarrow \frac{kQ_1}{R_1} \neq \frac{kQ_2}{R_2}$

$Q_1R_2 \neq Q_2R_1$

56.



energy stored $(U) = \frac{q^2}{2C}$

After connecting with another capacitor

$V_{Common} = \frac{q_1 + q_2}{C_1 + C_2} = \frac{q + 0}{C + C} = \frac{q}{2C}$

$\because$ Energy on each capacitor

$= \frac{1}{2} C V_{Common}^2 = \frac{1}{2} C \left(\frac{q}{2C}\right)^2 = \frac{1}{2} \frac{q^2}{4C} = \frac{U}{4}$

57. $\frac{1}{C_{eq}} = \frac{1}{3} + \frac{1}{10} + \frac{1}{15}$

$C_{eq} = 2\mu F$

$Q_{eq} = (2 \times 100)\ \mu C = 200 \mu C$

58. $V_A = \frac{C_B}{C_A + C_B} V_T = 6V \Rightarrow V_B = (10 - 6)V = 4V$

$\Rightarrow \frac{V_A}{V_B} = \frac{3}{2}$

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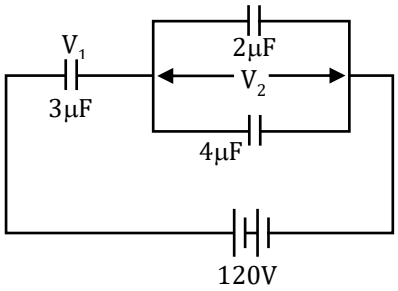
59. $U_s = \frac{1}{2}kx^2 = 500\,J \qquad \left[k = \frac{F}{x}\right]$

$U_C = \frac{1}{2}CV^2 = 500\ J \Rightarrow \frac{U_s}{U_c} = \frac{1}{1}$

60.



$C_{eq} = \frac{6\times3}{6+3} = 2\mu F$

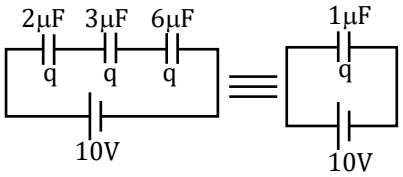
$\therefore\ Q = 120 \times 2\ \mu C = 240\mu C$

$V_1 = \frac{240}{3} = 80\ V$

$V_2 = 40\ V \Rightarrow Q_2 = 40 \times 2 = 80\ C$

$Q_3 = 40 \times 4 = 160\ C$

61.



$\frac{1}{C} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} = \frac{6}{6} \Rightarrow C = 1\ \mu C$

$\Rightarrow q = 10^{-6} \times 10 = 10\ \mu C$

62. After connecting V become same

$\frac{E_a}{E_b} = \frac{b}{a}$

63. $C = \frac{4\pi\in_0 R_1R_2}{R_2 - R_1}$

64. $C = \frac{4\pi\in_0 b^2}{b-a}$

65. $\tau = RC$

66. Energy density $= \frac{1}{2}\in_0 \frac{V^2}{d^2}$

67. $V_{common} = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$ { $\because\ V_2 = 0$)

$\Rightarrow V_{common} = \frac{C_1V}{C_1 + C_2}$

68. Potential same at both spheres $V_1 = V_2$

$\therefore\ \frac{kQ_1}{R_1} = \frac{kQ_2}{R_2} \Rightarrow \frac{Q_1}{Q_2} = \frac{R_1}{R_2}$

surface charge density

$\therefore\ \frac{\sigma_1}{\sigma_2} = \frac{Q_1}{4\pi R_1^2} \times \frac{4\pi R_2^2}{Q_2}$

$= \frac{Q_1}{Q_2} \times \left(\frac{R_2}{R_1}\right)^2 = \left(\frac{R_1}{R_2}\right)\left(\frac{R_2}{R_1}\right)^2$

$= \frac{R_2}{R_1} = \frac{20}{10} = \frac{2}{1}$

69. $C_{eq} = 4\mu F$ (Wheat stone bridge)

70. By charge conservation

$V_{com} = \frac{6\times12 - 3\times12}{9} = 4\ Volt$

71. $V_{com} = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$

$= \frac{0.2\times600 + 1\times0}{0.2+1}$

$= 100$ volt

72. $U = \frac{q^2}{2C} = \frac{q^2d}{2\in_0 A}$

Volume = Ad

Energy Density $= \frac{U}{Volume} = \frac{q^2}{2\in_0 A^2}$

73. $W = \frac{1}{2}CV_2^2 - \frac{1}{2}CV_1^2 = \frac{1}{2}C(900-225)$

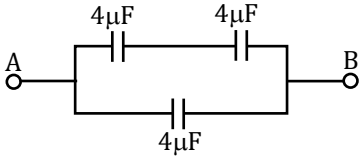
$C = \frac{2}{675}W$

Now in 2nd case

$\frac{1}{2}C\left[(60)^2 - (30)^2\right] = \frac{1}{2}C\left[3600 - 900\right]$

$= \frac{1}{2}.\frac{2}{675}W\left[2700\right] = 4W$

74.



$C_{AB} = (2 + 4)\ \mu F = 6\mu F$

75. $\frac{Q_1}{Q_2} = \frac{C_1V}{C_2V} = \frac{C_1V}{KC_1V}$ ($\because$ V = const.)

$\Rightarrow K = \frac{Q_2}{Q_1} = \frac{100}{40} = 2.5$

76. $C_{net} = \frac{C}{2}, V_{net} = 2V$

77. $C_{eq} = 2\mu F$
$Q_{eq} = 4\mu C$
Q on $1\mu F = 2\mu C$
Q on $2\mu F$ each $= 2\mu C$

78. E remain same because V = constant

79. $P = \frac{W}{t} = \frac{\frac{1}{2}CV^2}{t} = \frac{\frac{1}{2}\times 40\times 10^{-6}\times (3000)^2}{2\times 10^{-3}}$

$= 9 \times 10^4 = 90$ kW

80. $C_S = \frac{C_1C_2}{C_1+C_2}$

$C_P = C_1 + C_2$

81. $V \propto \frac{Q}{R}$ So $Q \propto R$ at constant V

So $\frac{q_1}{q_2} = \frac{R_1}{R_2}$

82. $V_{com.} = \frac{Q}{C_1+C_2} = \frac{Q}{4\pi\in_0 (R_1+R_2)}$

$= \frac{150\times 10^{-6}\times 9\times 10^9}{(10+20)\times 10^{-2}} = 4.5\times 10^6 V$

83. $\frac{1}{2}C_1V_1^2 = \frac{1}{2}C_2V_2^2$ [Assume no energy lost]

because total energy is transferred (given).

$\therefore \frac{1}{2} \times 900 \times 10^{-6} \times 100^2 = \frac{1}{2} \times 100 \times 10^{-6} \times V^2$

$\therefore V^2 = 90000 \Rightarrow V = 300$ Volt

Exercise-II (Previous Year Questions)

1. According to question
Q = constant and C↓ therefore V↑

2. $Q_C = CV$; $Q_{C/2} = \frac{C}{2}V$

$\therefore Q_{net} = Q_C + Q_{C/2} = \frac{3CV}{2}$

$W_{battery} = \left(\frac{3CV}{2}\right)V = \frac{3CV^2}{2}$

3. Energy required $= CV^2 = \left(\frac{A\in_0}{d}\right)(Ed)^2 = A\in_0 E^2 d$

4. $C_{net} = \frac{C}{3}, V_{net} = 3V$

5. In 1st case

$U_1 = \frac{1}{2}CsV^2 = \frac{1}{2}\left(\frac{C_1}{n_1}\right)(4V)^2$

$\Rightarrow U_1 = 8\frac{C_1}{n_1}V^2$

In 2nd case

$U_2 = \frac{1}{2}C_pV^2 \Rightarrow U_2 = \frac{1}{2}(n_2C_2)(V^2)$

from question $U_1 = U_2$

$\Rightarrow 8\left(\frac{C_1}{n_1}\right)V^2 = \frac{1}{2}(n_2C_2)V^2$

$\Rightarrow \frac{C_2}{C_1} = 16\left(\frac{C_1}{n_1n_2}\right)$

6. $E = \frac{E_0}{K}$

7. Energy = Energy Density × Volume

$= \frac{1}{2}\varepsilon_0E^2 \times (A \times d) = \frac{1}{2}\in_0E^2Ad$

8. Electric field, $E \propto \frac{1}{K}$ As $K_1 < K_2$ so $E_1 > E_2$

9. Once the capacitor is charged, its charge will be constant Q = CV. When dielectric slab is inserted

$C'_{New} = KC$

$E = \frac{Q^2}{2C} \Rightarrow E_{New} = \frac{1}{K}E_{initial}$

$V = \frac{Q}{C}$ so $V_{new} = \frac{1}{K}V$

10. $F = \frac{Q^2}{2\varepsilon_0A}$

$\because Q = CV$ and $C = \frac{\varepsilon_0A}{d} \Rightarrow \varepsilon_0A = Cd$

So $F = \frac{C^2V^2}{2Cd} = \frac{CV^2}{2d}$

11. Initial energy stored in capacitor 2 μF

$U_i = \frac{1}{2}2(V)^2 = V^2$

Final voltage after switch 2 is ON

$V_f = \frac{C_1V_1}{C_1+C_2} = \frac{2V}{10} = 0.2$ V

Final energy in both the capacitors

$U_f = \frac{1}{2}(C_1+C_2)V_f^2 = \frac{1}{2}10\left(\frac{2V}{10}\right)^2 = 0.2\ V^2$

TG: @Chalnaayaaar

So energy dissipated $= \frac{V^2 - 0.2V^2}{V^2} \times 100 = 80\%$

12.

K_1	K_2	K_3
K_4		

K_{123}
K_4

$$K_{123} = \frac{K_1 + K_2 + K_3}{3}$$

$$\text{Now } \frac{2}{K} = \frac{3}{K_1 + K_2 + K_3} + \frac{1}{K_4}$$

OR

Put $k_1 = k_2 = k_3 = k_4$ and check answer

13. $U_i = \frac{1}{2}CV^2$

$$U_f = \frac{1}{2}[2C]\left[\frac{V}{2}\right]^2 = \frac{1}{2}U_i$$

Decrease by a factor of 2

14. $F = QE = Q\frac{\sigma}{2\epsilon_0} = \frac{Q^2}{2A\epsilon_0}$

$\therefore$ Electrostatic force is independent of distance between plates

15. $U_{initial} = \frac{1}{2}CV^2$,

$$\text{Loss} = \frac{C.C}{2(C+C)}(V-0)^2 = \frac{1}{4}CV^2$$

$$\% \text{ Loss} = \frac{\frac{1}{4}CV^2}{\frac{1}{2}CV^2} \times 100 = 50\%$$

16.

(A)	(B)
R	2R
σ	σ

Total charge $= \sigma \times 4\pi R^2 + \sigma \times 4\pi (2R)^2$

$= 20\,\sigma\pi R^2$

$$\frac{Q_A}{Q_B} = \frac{1}{2}$$

$$Q_A = \frac{20}{3}\sigma\pi R^2 \text{ and } Q_B = \frac{40}{3}\sigma\pi R^2$$

$$\sigma_A = \frac{Q_A}{\text{area}} = \frac{20}{3}\frac{\sigma\pi R^2}{4\pi R^2} = \frac{5\sigma}{3}$$

$$\sigma_B = \frac{40\sigma\pi R^2}{4\pi(2R)^2} = \frac{5\sigma}{6}$$

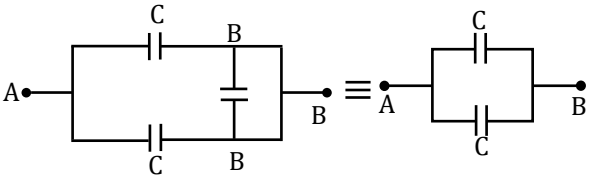
17. $C_m = \epsilon_r C_o \Rightarrow \epsilon_r = \frac{30}{6} = 5$

$\epsilon = \epsilon_0\epsilon_r = 8.85 \times 10^{-12} \times 5 = 0.44 \times 10^{-10}$

18. $C_0 = \frac{\epsilon_0 A}{d}$

$$C_K = \frac{\epsilon_0 A}{d - t + \frac{t}{k}} = \frac{\epsilon_0 A}{d - \frac{d}{2} + \frac{d}{8}} = \frac{8}{5}\frac{\epsilon_0 A}{d} = \frac{8}{5}C_0$$

19.



(one capacitor gets shorted)

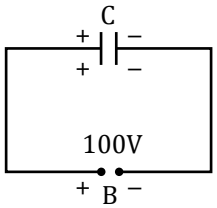
$\Rightarrow C_{eq} = C_1 + C_2$

$= C + C = 2C$

20. $E = \frac{1}{2}CV^2 = \frac{1}{2}\left(\frac{\varepsilon_0 A}{d}\right)(Ed)^2 = \frac{1}{2}\varepsilon_0 E^2 Ad$

21. Polar molecules have centres of positive and negative charges separated by some distance, so they have permanent dipole moment.

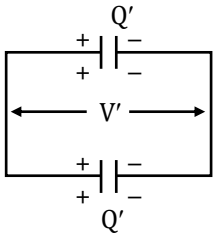
22.



$Q_i = CV$

$= 900 \times 10^{-12} \times 100$

$Q_i = 9 \times 10^{-8}\,C$



$Q_f = 2Q'$

From conservation of charge

$2Q = Q_f = Q_i$

$$Q' = \frac{Q_i}{2} = \frac{9\times10^{-8}}{2}$$

$$Q' = 4.5\times10^{-8}C$$

$$E_{store} = 2\times\frac{1}{2}\frac{(Q')^2}{C}$$

$$= \frac{\left(4.5\times10^{-8}\right)^2}{900\times10^{-12}}$$

$E_{store} = 2.25 \times 10^{-6}$ J

24. $C = \frac{A\varepsilon_0}{d}$

$$C' = \frac{A/2\,\varepsilon_0}{2d} = \frac{A\varepsilon_0}{4d} = \frac{C}{4}$$

25. $\frac{C_1C_2}{C_1+C_2} = 3$

$C_1 + C_2 = 16$

$C_1\,C_2 = 48$

$C_1 = 12\mu F$

$C_2 = 4\mu F$

Exercise-III (Analytical Questions)

1. $\because$ battery is connected

$\therefore$ V = constant

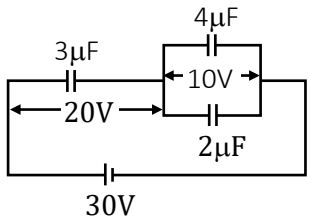
$U = \frac{1}{2}CV^2$, $Q = CV$

$U \propto C$, $Q \propto C$

4. $U = \frac{1}{2}\in_0 E^2$ (Ad)

$U \propto E^2$

5.



$\because V \propto \frac{1}{C}$

$Q_{Battery} = C_{eff}\,V = 2 \times 20\ \mu C$

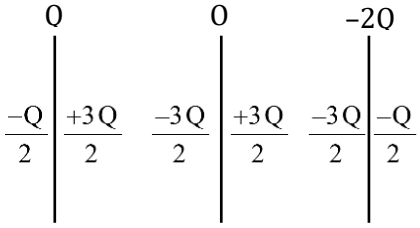
$Q_{battery} = 60\ \mu C$

$Q_{3\mu F} = 60\mu C$

$Q_{4\mu F} = 40\mu C$

$Q_{2\mu F} = 20\mu C$

6.



7. $U_{self} = \frac{KQ^2}{2R}$ Energy density $= \frac{1}{2}\varepsilon_0 E^2$

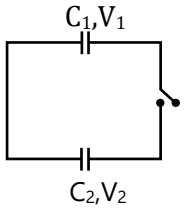
$F = \frac{Q^2}{2A\varepsilon_0}$ $W_{field} = U_i - U_f = \frac{kQ^2}{R} - 0$

$W_{field} = \frac{kQ^2}{R}$

8. Force between two point charges is independent of the presence of other charges.

9. $C = 4\pi\varepsilon_0 R \Rightarrow 1 = \frac{1}{9\times10^9}R \Rightarrow R = 9\times10^9 m$

10.



$V = \frac{C_1V_1 + C_2V_2}{C_2 + C_2}$

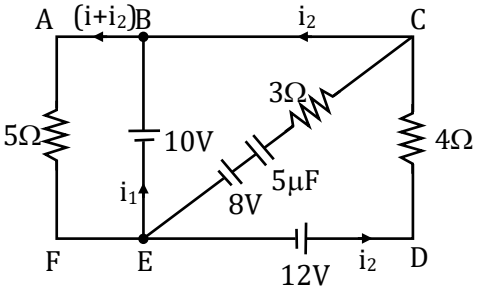
When two capacitors are connected then energy of system decreases. (but Not always)

11. A high capacity capacitor charged to high voltage has very high charges, that may discharge to ground through human body, when touched with bare hands.

12. $U = \frac{Q^2}{2C}$ and $C = \frac{\varepsilon_0 A}{d}$ d↑ C↓ U↑

13. At facing surface same magnitude and opposite nature charges are there.

14.



When a steady state is reached, no current passes through the capacitor or the branch CE.

Considering the loop ABEFA,

$5 \times (i_1 + i_2) = 10$ or $i_1 + i_2 = 2A$...(i)

Considering the loop BCDEB

$4i_2 = 12 - 10 = 2 \Rightarrow i_2 = 0.5$ A

So $i_1 = 2 - 0.5 = 1.5$ A

To find the charge on capacitors, we must know potential difference across the plates.

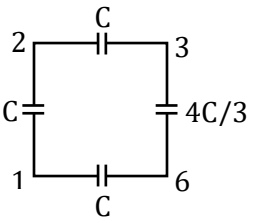
TG: @Chalnaayaaar

Consider the loop CEDC :

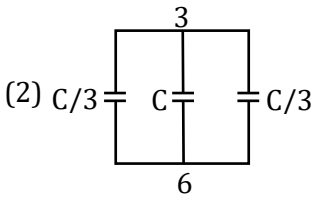
$-12 + 4i_2 + 3 \times 0 - V_C + 8 = 0 \Rightarrow V_C = -2V.$

So, charge on capacitor $Q = CV = 10\ \mu C$

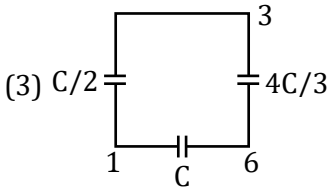
16. (1)



(2)



(3)

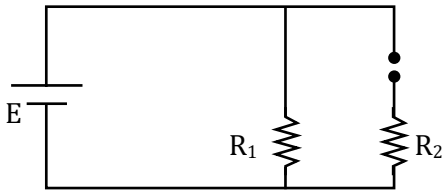


18. In steady state current through battery

$$I = \frac{50}{23+3+17+7} = 1A$$

$\Rightarrow Q_{10\mu F} = CV = 10 \times 20 = 200\mu C$

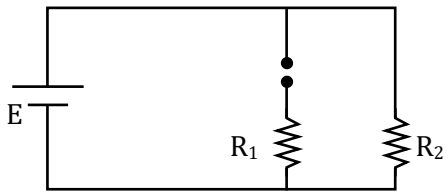
19.



At t = 0

$I_1 = \frac{E}{R_1} = \frac{25}{5} = 5A$

$I_2 = 0$



At $t = \infty$

$I_1 = 0$

$I_2 = \frac{E}{R_2} = \frac{25}{10} = 2.5\ A$